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ABSTRACT

There has been sufficient research in the area of conceptual change that indicates that students' conceptions or alternative theories are much more resistant to change than was previously thought. The work of cultural anthropologists, and more recently science educators, points to the role of individual world views in the learning of science concepts. A world view is one's fundamental assumptions and presuppositions concerning perceptions of reality. The purpose of this ethnographic investigation was to shed light on the dynamic interaction of individual world views within an elementary science methods course in relation to understanding science and nature and how these presuppositions influence individuals' view of science teaching. The subjects for this study were 30 students enrolled in a science methods course at Temple University. Ten of these students participated in the interviews reported here. The outcomes of this investigation revealed that students do not view themselves as part of science or nature. The investigation also uncovered students' views of the self, nonself, relationship, and causality that affect their learning and view of science teaching. This investigation provides further demonstration of the influence of world views and the interplay of those views with the notion of scientific literacy. Contains 47 references. (Author/CCM)

World view: Defiining the Cultural Context of the Teacher

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Abstract

There has been sufficient research in the area of conceptual change that indicates that students' conceptions or alternative theories are much more resistant to change than was previously thought. The work of cultural anthropologists and, more recently science educators, points to the role of individual world views in the learning of science concepts. A world view is ones fundamental assumptions and presuppositions concerning perceptions of reality. The purpose of this ethnographic investigation was to shed light on the dynamic interaction of individual world views within an elementary science methods course in relation to understanding science and nature and how these presuppositions influence individuals' view of science teaching. The subjects for this study were 30 students enrolled in a science methods course at Temple University. Ten of these students participated in the interviews reported here. The outcomes of this investigation revealed that students do not view themselves as part of science or nature. The investigation also uncovered students' views of the self, nonself, relationship and causality that affect their learning and view of science teaching. This investigation provides further demonstration of the influence of world views and the interplay of those views with the notion of scientific literacy.

World View: Defining the Cultural Context of the Teacher

Since the late 1970's conceptual change theories have spawned research and debate in science education. Based on this research, a variety of conceptual change pedagogues have been created and implemented. This line of research has been grounded in the learning theories of constructivism and cognitive psychology. The constructivist learning models that have been developed and implemented to ameliorate students' mis-conceptions or alternative frameworks have promised to lead to reform in science education. This reform is supposed to translate into a more scientifically literate society. Not only have traditional pedagogical methods come under attack through these reforms but, more recently, the notion of conceptual change and resulting pedagogues have also spawned critical debate (Cobern, 1991; Hills, 1987, 1989; & O'Loughlin, 1992,).

There has been a considerable amount of research in the area of conceptual change that indicates that students' conceptions or alternative theories are much more resistant to change than was previously thought (Wandersee, Mintezes, & Novak, 1994). Two complimentary theories and areas of research have emerged to challenge conceptual change approaches to science education. Emancipatory constructivism, radical, and social constructivism challenge the assumptions of traditional constructivism through looking at the social and political context of schools and society. These frameworks have their roots in critical theory, feminist theory, and cultural anthropology. These views challenge the supposed superiority of scientific conceptions compared to other conceptions of knowing and understanding the world. According to O'Loughlin (1992) "Emancipatory constructivism is best viewed as a reaction against the positivist doctrine that objective truth exists and that by using certain rational modes of thinking we can arrive at authoritative knowledge that can then be imparted to others" (p. 336). Similarly, world view theory in science education asserts that students' conceptions of their world are based on untutored beliefs that are

socially-culturally influenced and provide the ways in which they make meaning in their life as well as interact with their environment and other people (Cobern, 1994). Knowledge, according to both views, is constructed and grounded in an individuals' interpretation of the world in which they live. Both views have similar criticisms of science education as well as similar goals. Both seek to uncover students' views of the world in the context in which they think and act. Emancipatory and radical constructivists focus on the socio-cultural and economic dimensions of the inequality of power so that people may be empowered to change those inequalities (Apple, 1978; Giroux, 1988; Lewis, 1990 &Weiler, 1991). World view theory adds a new dimension to the continuing conversation of science education for all. It will help science educators engage in understanding the presuppositions of the world that students bring to class with the hope that we can better find a place for science in the cognitive framework of these students. Both theories help explain why students' beliefs or conceptions are resistant to change.

World view theory, as studied by anthropologists, has been around since the 1950's but only recently have theoretical frameworks and models been developed so that the theory might be tested by studying people and their behavior. World view theory compliments the research of radical constructivists by addressing the cognitive as well as the socio-cultural milieu of individual students in addition to society and culture as a whole. Understanding the interplay of students' world views in the science classroom may be an important step towards accepting and addressing student learning of science and the teaching of science. More importantly, research in this area may lead to an understanding of the notion of science literacy.

According to Jones (1972, p. 83) world views involve beliefs. Specifically,

> the world view of any individual is a set of very wide-range vectors in that individual's belief space that he learned early in life and that are not readily changed and that have a determinate influence on much of his observable

> behavior, both verbal and nonverbal, but that he seldom or never verbalizes in the referential mode, though they are constantly conveyed by him in the expressive mode and as latent meanings.

People often can not explain why they believe what they do. The definition also points out that world views are developmental and that concepts are resistant to change. Jones (1972) based his model of world view universals on the comparative analysis of many cultures. It has however, yet to be used in any educational research. Kearney (1984) developed a model of world view and applied it to the study of several cultures. This theory and model advocated similar notions as Jones' but was based on a more Marxist version of reflexive anthropology. "The world view of a people is their way of looking at reality. It consists of basic assumptions and images that provide a more or less coherent, though not necessarily accurate, way of thinking about the world" (Kearney, 1984, p. 41). World views are expressed in peoples actions with their world. It is what they presuppose about their world and it accordingly drives their actions. Therefore, it affects learning. Although there are many fundamental similarities in the underlying assumptions about world view on the part of both Jones and Kearney, it has been Kearney's model of logico-structuralism that has been used in the most recent studies in science education. The seven world view universals identified by Kearney (1984) include: Self, Other, Relationship, Classification, Causality, Time, and Space.

World view theory is important to research in science teaching because it illuminates the concept of accommodation or adaptation of scientific knowledge and understanding. It assumes accommodation and/or adaptation is not necessarily automatic but that the knowledge presented must be of sufficient scope and force in order to fit within students' current understanding of the world. According to Cobern (1996) "a concept or belief has force if it is central in an individual's thinking rather than marginal. A concept or belief has scope if it has relevance for the individual over a wide range of contexts" (pg. 2). This world

view model was applied to the teaching and learning of students in an elementary science methods course at Temple University. It was applied in analyzing and understanding the world view variations of students within the classroom as they learned key concepts regarding science and nature. The seven world view universals interact with learning. How they particularly influence the learning of concepts of science and nature was examined. For example, it was hypothesized that those students who viewed themselves as part of science would have an understanding of the concepts to be examined and better equipped to teach science concepts than those who viewed themselves as separate from science (Nonself). Ones' locus of Self can be seen in some individuals viewing themselves as intimately interconnected with the Other. For example, some students will view themselves and nature as one. Others will view nature as separate and distinct from themselves. In addition, based on their notions of causality, students may view events in nature as random and unpredictable or as knowable and predictable. How students classify the Self and Other will indicate their world view and in turn affect how they learn and ultimately how they view the teaching of science. For example, some students will classify things very generally whereas others will be very particular. Students who classify generally will not see each plant or animal as being distinct and unique. Someone with a particular versus generic focus would express that humans are separate from other animals as opposed to being part of everything else.

In understanding students' beliefs about the world and how these are both supported and maintained by students' cultures perhaps science education can successfully integrate students' ways of knowing and scientific ways of knowing. Or, science educators may be confronted with a different view of what is considered scientifically literate. Indeed, we may realize that for many of our students science literacy is a notion that is of little or no interest or importance. Consequently, as science educators we may become more enlightened regarding an evolving concept of science literacy.

Given a teacher's central role in the classroom, it is reasonable to hypothesize that classroom culture is a function of a teacher's world view. In teaching science, teachers not only present scientific concepts, but tacitly create a context in which scientific concepts are presented, a context influenced by teachers' world view. Therefore, the world views of teachers must be examined to fully understand the cultural context created by the teacher within the classroom. The research described in this paper is based on the assumption that much can be gained through an understanding of why particular world views make sense to teachers.

Procedures

Sample

This study took place during the Spring semester of 1996, with thirty students enrolled in a science methods course at Temple University. The researcher was the instructor of this course. Ten of these students participated in the interviews. Purposeful sampling was utilized for the initial study while a theoretical sample was used to select the ten students to be used as comparative case studies based on the recommendations of Strauss (1987). According to Strauss (1987, p. 38) " theoretical sampling is a means whereby the analyst decides on analytic grounds what data to collect next and where to find them.' The basic question in theoretical sampling is: What groups or subgroups of populations, events, activities (to find varying dimensions, strategies, etc.) does one turn to next in data collection. And for what theoretical purpose?" Consequently, this portion of data collection is directed by emerging ideas and theories. There were thirty students in the initial purposeful sample. The students who participated in the case study interviews did so on a voluntary basis and were randomly selected from the four groups determined from initial instruments completed by all thirty students. Pseudonyms were used and results were provided to participants. A biography of each of the ten students was prepared to

summarize background information and information obtained while interacting with students both in and out of class.

Data Gathering Instrument

To gather data to complete descriptive and comparison case studies, ten students were randomly chosen to be interviewed. Interviews were semi-structured and open-ended. Interviews were conducted based on the suggestions of Roth (1989), Kvale (1987), and Lythcott & Duschl (1990). The main questions that guided these interviews are shown in Table 1. These were chosen to represent common differences in students ideas as identified by Wandersee, Mintzes, & Novak (1994) in their review of research on alternative conceptions in science. In order to encourage student reflection and discussion of their views these questions merely served as a starting point. While the probing questions may have differed for each interviewee, the main questions remained the same. The interviews were designed to elucidate students beliefs concerning science and nature. Each interview lasted approximately one hour and was recorded and later transcribed verbatim. The second interview was conducted approximately two weeks after the initial interview upon preliminary coding and analysis of the first interview.

Insert Table 1 about here

Methodology

The overall conception of the whole study is that a of a micro-ethnography (Bogden & Biklen, 1982). As such, it was an emergent case study of a small part of a larger organization. The sample of students that participated in the interviews were part of this larger micro-ethnographic study that included the use of several other instruments. The use and analysis of all the data combines what Tesch (1990) has described as ethnographic

content analysis. The larger study focused on students as they interacted in the classroom but it also considered their life setting, their culture, and what they do and do not believe. This particular part of the study attempted to describe the context of students' world views and, to describe the interactions of their world views as they learned concepts in science and nature.

A background demographic instrument was developed in order to determine the personal context, history and other information that would illuminate the formation of students' world views. A World View Questionnaire that was given with the demographic instrument aided in the delineation of differing world views. To further explore students views on science and nature, students were given ten questions on the nature science. These open-ended questions were used to show how students understood and viewed science and non-science. The responses to these two instruments were analyzed to determine students' world views. Using the whole class as a case study aided in grouping students based on the World View Questionnaire and the ten questions on the nature of science. Based on analysis, students were grouped into similar world view types.

A complete description of each of these instruments and the analysis of them is beyond the scope of this paper. Instead, the focus will be on the students selected for the interviews based on the groups identified from the two instruments described above. Each of the four groups identified contained students with differing views on the nature of science, relationship to science, and causality. The open-ended interviews specifically explored students' views of Self, Other, Classification, Relationship, and Causality as they related to their views of science and nature. Two students were chosen from group one, three and four, while four students were chosen from group two. More students were selected from group two because it seemed to represent the predominant view. According to Cohen and Manion (1989) this type of quota sampling attempts to "obtain representatives of the various elements of the total population in the proportions in which they occur" (p. 103). Students in group two view themselves as separate from science and their views on causality rest heavily

on the unpredictability of nature. Therefore, it was hypothesized that students in this group may possess world views that may hinder the understanding or acceptance of science concepts and explanations while those students in group four would possess views that would accommodate understanding. Students in group four view themselves as part of science and believe that nature is knowable and predictable. In addition, they possess traditional views of science. Students in groups one and three had diverse views that made it difficult to hypothesize how they might learn science.

Grounded theory was used as a method of analysis. Grounded theory seeks to develop a theory without commitment to specific types of data collection or theoretical interests (Strauss, 1987). It utilizes the constant comparative method and coding paradigms that aid in the uncovering and development of themes, assertions, and constructs. It seeks to generate a theory based on data that the theory is grounded in. Ideas emerge from the organization, sorting, coding, and categorization of the data. Cases were examined individually and as a whole for themes and patterns. From these, preliminary assertions were made and data from the cases were highlighted as to possible warrants to support these assertions. Several themes emerged that were based on science and nature, as well as groupings of assertions within these areas, two final assertions were made. The data were re-examined to report warrants that confirmed or disconfirmed the final assertions. "Warrants are those things which allow one to move from data to conclusions in a defensible fashion" (Lythcott and Duschl, 1990, p. 451). In other words, warrants are how one gets from data to assertions or premises. These warrants and assertions were cross checked by interviewing students a second time in order to confirm or disconfirm data collected initially. The coding of notes and analysis of data included both inter-rater and intra-rater reliability as well as several other provisions for trustworthiness that included member checking and an instructors log. Intra-rater reliability was achieved by the researcher checking codes three times and achieving a 90% agreement. Inter-rater reliability was achieved by using an

outside researcher not involved with the study to cross check the coding and assertions and examples or warrants used to confirm or disconfirm the data. A 85% per cent agreement was achieved.

Outcomes

Discussion of Assertions

Assertion #1: The majority of the ten students interviewed see themselves connected to nature intellectually but do not associate themselves on a deeper level with the natural world. The words and language used to describe nature are filled with a variety of perspectives that do not include themselves. In addition, science and science talk were notably absent from their discussions of nature. The relationship of self would be classified as separate from nature. Nature would be classified as "Nonself" in these students' world view schema. As Cobern (1993, 1995) has demonstrated in several studies with both high school and college students science is rarely mentioned when discussing or writing about nature. In addition, this study shows that they do not talk about themselves in relation to nature. MG is a good example of the type of response in regards to views on nature.

Interviewer: What is nature?

MG: I guess its kind of your environment, like living and non-living things... the environment.

Interviewer: Where do you fit in?

MG: Well, I'm part of it.... even though I kind of look at nature as a little bit separate from myself.... I was just thinking about this, how people see themselves as bigger than like plants and animals and stuff like that.

Interviewer: What do you think?

MG: I think that I might generally think it.... um... like I think when I look deeper I know that I am part of the environment and nature. But, I could easily get strayed from that.

Interviewer: Why do you think that?

MG: I think that people see themselves as superior... not like race, superior race, but beings.

Interviewer: Why?

MG: Cause we can rationalize and make choices... I just think that is what we think.

Students expressed these same themes to different degrees. For example, LD believes that we were once closer to nature than we are now.

LD: I think nature is your surroundings, your environment like outside, trees, plants and all of that. Plants are living but the environment is living and non-living and nature is just the living. You can have both living and non-living stuff in your environment.

Interviewer: Where do you fit in?

LD: I see myself as part of it cause I am a living thing and I am in my environment. Well, we were more a part of nature in the past but not as much now cause we don't live in the wilderness- we don't live with them. Our ancestors were more in touch with nature than we are now.

This same sentiment is expressed by MA. On the one hand she appears to acknowledge intellectually humans relationship to nature but on the other hand she feels that she personally has nothing to do with it in her own life and so sees herself separate from it. For her, nature is classified as "other".

I fit in, people fit in cause they are part of nature. Nature to me is more like animals, forest type thing not like I would never think of myself as being part of it. But you

are part of it but you don't live out in the wilderness like we used to. I don't see myself.... cause nature is more like a park or more wild or something.

None of the students mentioned themselves in their discussions of nature until they were asked how they fit in. Only one of the students expressed an undeniable personal relationship to nature when pushed. SH feels that she is at one with nature. This mystical environmentalist philosophy of nature is expressed in the following statement:

SH: I feel like I am a very integral part of the scene that I have in my mind. Gee.. I guess I see myself as probably all of nature. I see myself as the oak tree, the grass, the water. I see myself as all of that.

Interviewer: What is not nature?

SH: I see things as not myself as things that would harm or otherwise disrupt the flow of the natural or my thoughts and my actions.

Only one other student showed this proclivity toward a deeper connection with nature. LC was most adamant about our connections to nature because of our past biological ties. She is also the only person who mentioned religious views in her understanding of nature. She also talked about biology to show her connection of science to her understanding of our ties to nature and also how it tied in with her religious beliefs.

LC: I am not an outdoorsy person but I am into natural things like shampoos and food like vegetables that are like organic. I try to buy that stuff for my son so they don't have pesticides and stuff on them.

Interviewer: Where do you fit in with what you think about nature?

LC: Oh, I am part of nature because I think we all came from nature like they say we all came from dirt so I believe that we are all part of nature cause we all gods creatures.

Interviewer: Can you say more about that?

LC: I mean when you look at the apes and the Java man and all that, I kind of believe that. I don't think we came from fish but I think they could be down the line cause apes their intelligence is so much like ours.

In summary, there does not appear to be a pattern based on the assigned groupings of the students. Of the four groups of students, all with the exception of SH and LC classified self separate from nature. SH, from group two, expressed a more philosophical brand of self as part of nature while LC, from group three, expressed a more practical and scientific view of self as part of nature. In their responses concerning the nature of science common themes pervaded. Students see nature as the wilderness, plants and animals or as life that exists in natural, not human-made, settings. They do not mention themselves as part of nature unless asked and this indicates that they intellectually know they are part of nature but do not intrinsically feel part of nature. In addition, they do not see science as part of nature. They do not mention science nor do they discuss the underlying orderliness and predictability of nature when asked to describe it. This self as separate from nature is indicative of what Kearney (1984) has described as part of a Western and typical American world view. This view is consistent with the fact that all of these students have lived in large metropolitan areas where parks and natural areas are not readily accessible. The world view of the Self is expressed in an awareness of the Self distinct from the surroundings of nature or Nonself. If the Self were viewed as continuous with Nonself, in this case nature and society, an attitude of respect and maintenance toward Nonself would be a by product of self-interest. As shown by these data, this is not the case. Belief in spiritual and supernatural forces may only reinforce a view that considers the environment to be in the hands of God and ultimate environmental catastrophe. All ten students report strong religious or supernatural beliefs and these views promote further distinction between the Self and Nonself. If the self is not viewed as part of nature and nature is not viewed as science then there can be nothing left except reliance on supernatural beliefs or a sense of powerlessness.

Assertion #2: Teacher candidates, participating in this study, tend to view humans as superior to other forms of life because of perceived higher abilities to think logically and rationally. Although students want to believe that all life is equal, they typically fall back on notions of man having dominion over the earth or, that humans have become more intelligent. In tandem with assertion number one, this second assertion extends the overall theme of the world view of these students that would classify nature and humans as separate. Clearly, most students statements corroborate nature as something outside of the self. Viewing humans as superior validates this view. Only two students, YS from group four and LC from group three, did not view humans as superior. Once again, there did not appear to be any pattern based on the original grouping of students and their views on classifying humans and nature. To varying degrees the eight other students felt that humans were somehow superior to all other life on earth. Kearney (1984) describes this world view as very much aligned with a western world view and traditional positivistic science. It also coincides with western religious beliefs that views humans has having been given dominion over the earth. Although SH expressed connection with nature this twenty-three year old single African American female believes that humans were put here to take care of the earth but she has doubts about our ability to do so based on mis-use of science and technology.

> I believe that it (human life) is qualitatively different. I believe that humans have the ability to do certain things that other life forms may no be able to do. However, superior in a sense yes that God put us here to take care of the earth. We are all suppose to take care of each other but I do believe that God put us here to take care of the earth. However, the way that we as humans act and create certain things which we know will destroy or hurt us tends to make you wonder whether that statement is really true. We are not taking care of the earth.

Seven students specifically spoke of human intelligence as the reason for our superiority. MG simply expresses that we are superior "because we can rationalize". ES supports this

view when she says: "I believe that to be true but all life is important but I think we are better cause we think and others don't." When pressed as to why she thought this ES replied: "that is just what I think. We kind of control everything. Well, it may not be true but that is just what I think." The response and tone indicated that this view is deeply held. When pressed further to elaborate ES became frustrated and simply exclaimed that "that is just what I believe".

Listening to MS, it is clear that he is confident that humans are superior, however, he too is concerned about the misuse of this superiority.

> I would say our mental capacity is more superior and our mental judgments and emotions. Our ability to do just about anything that any other species of animals can... like our technology we can drive, fly, just like animals and so in that way. I think we get caught up too much and looking at what we can create and saying 'oh wow we can do this and that' and not worrying about the consequences of what we are doing. Like with deforestation and pollution from our technology. People say technology is so great but it is also killing us.

MA combines her religious views with how she thinks of humans compared to other living things.

> I think we are more intelligent. It's not that we are superior it's just that we don't live like other animals do. God created two different types, those that live outside and off the earth..... well God created us differently.

In discerning the difference between humans and other life forms, FM expresses her belief in human superiority this way: "I just think there was this one smart genius person and he said OK we have more sense than they do and we will take this over". The above eight cases cited all convey a sense of students views on the superiority of humans. In contrast, two students believe that humans are not superior but do not clearly indicate why. For

example, this excerpt from YS shows her frustration in explaining why she feels humans are not superior.

> Let me say not that I don't believe so but let me say that I don't believe that there is any way of knowing that. It could be..... I don't think that we are above other things in nature cause we have no way of knowing that right now.

LC expresses that all life forms are equal because we are interconnected.

> No I don't think so. Our life is not more important. I think we need all of it. I mean cause I don't think we could survive if it was all just humans and not animals and plants, and oceans, I think we need everything.

To summarize this assertion, these ten students as a group were found to have similar views on the superiority of humans over other forms of life on earth. YS from group four, however, is not willing to say that humans are or are not superior. Instead, she discusses the importance of evidence. She believes there is no way to find this out and so insists that she cannot answer the question. Her original placement in group four was due to her identification with science and her views of science that were based on traditional methods such as observation and fact. LC, from group three, was also classified as viewing the self as part of science and possessing a traditional view of science. Otherwise, the other eight students' views did not seem to be dependent on the original groupings. The viewpoint that humans are superior to other forms of life compliments the views expressed in addressing assertion #1. On the one hand are the students who feel that humans were given dominion over the earth but these same students view humans as incapable or, as doing a poor job of "keeping the earth". On the other hand are students who simply view humans as superior, but do not mention the responsibility of humans for nature. Feelings of superiority may be linked to a Judeo-Christian or Calvinistic view that perpetuates the view that humans are superior because God granted people dominion over the earth however, this view is also linked to views that see nature as something to be conquered and overcome. This view of

stewardship is in contrast to a view of living in harmony with nature where human life is viewed as a part of all life. The science reform initiatives seem to want to perpetuate a little of both forms of stewardship. Accordingly, students should learn that nature is governed by orderliness and predictable patterns that are knowable but, they should also learn to live more in harmony with nature by practicing conservation and sound resource management. It seems possible that the two views are too different to be accommodated for in the minds of the students interviewed.

Limitations of the study

There are several limitations inherent in the sampling of this study. The students who participated were primarily women majoring in elementary education with limited science backgrounds. Of the thirty students, only ten participated in the in-depth interviews. Interviewing more students or even students majoring in secondary science education with this method may uncover further assertions as to the involvement of world views and the learning and teaching of science

Implications

"The conception of science as a kind of world view reflects a world view different from that which underlies the conception of science not as a world view but as our best means for coming to know the 'Truth' about the world" (Jones, 1972, p. 104). It can also be argued that for many cultures and people within our own culture, science may not be the best or only means for knowing and understanding the world.

Unfortunately, assuming that people do or can possess a scientific world view limits us from seeing how others preferences or views may interact with the learning of science. Some world views may be so disparate from science that learning science or even enrolling in post-secondary science is problematic. Others may already possess a world view aligned with learning science and science concepts. Still, others may be indifferent or learn only the

concepts they are interested in or, learn them simply to "pass" the class. Our society and culture devalue some ways of thinking and knowing to such an extent that all but Religious views are trivialized. In some cases even deeply held religious views are written off as is the case in many science classes. Students are often asked to keep their views separate or, as is most often the case, they are not asked to share their beliefs. Science education seeks to instill a scientific way of thinking and knowing. The goal is for all Americans to know and understand science. Unfortunately not all Americans share this zeal for science. Their world view precludes seeing science as important, interesting, and worthy of such intense preoccupation. It is not simply a matter of replacing students faulty views of science and science concepts. It is not a matter of what Hills (1986) has called the domestic affairs of science. For example, correcting students mis-conceptions assuming that they already subscribe to a view that includes science. Rather, as Hills (1986) explains, it is an exercise in foreign affairs. Helping students make sense of ways of thinking and knowing that are disparately different from their own ways of thinking and knowing. In other words, we must consider the deeply held views that affect the cognitive structuring and re-structuring of information. Indeed as this study and others (Cobern, 1993, 1995) have shown, students that already possess views that are aligned with science fair the best in our science classes. This study also confirms that students do not totally adhere to strict scientific thinking about science itself and about how the world functions. Most students learned the material for class and many accepted concepts but kept these separate from their personal and spiritual views. If world views are firmly entrenched by young adulthood is there any way that science classes can aid in the accommodation of scientific thought? Beyond simple conceptions based on naiveté or poor instruction, the learning of science concepts and the endeavor of science itself must consider the deeply held world views of students that affect their understanding of science and science concepts.

The implications of this as well as other studies on the notion of science literacy and science for all can not be understated. The endeavor of science itself can be argued to be both a lived world view as well as an articulated world view. According to the philosopher Kok (1988) a lived world view is akin to views that are similarly shared and essential. An articulated world view can be described as ideology or religion. A scientific world view would be a form of an articulated world view. It is becoming apparent from the research that there may be many types of articulated world views concerning science based on the lived world views of the individual. In other words, the science world view articulated by society may or may not be consistent the students' world view. Or, through schooling we may instill in students the ability to articulate a correct scientific world view but, it does not become a lived world view for the student. According Rutherford and Ahlgren (1990) students should leave high school with both an articulated and lived world view of science. This expectation is implicit in their definition of science literacy.

> Scientific literacy- which encompasses mathematics and technology as well as the natural and social sciences- has many facets. These include being familiar with the natural world and respecting its unity; being aware of some of the important ways in which mathematics, technology and the sciences depend upon one another; understanding some of the key concepts and principles of science; having a capacity for scientific ways of thinking; knowing that science, mathematics, and technology are human enterprises, and knowing what that implies about their strengths and limitations; and being able to use scientific knowledge and ways of thinking for personal and social purposes. (Rutherford and Ahlgren. 1990, p.x)

According to these authors, there is a scientific world view. A science world view presumes and believes that the world is knowable and predictable and that events occur in consistent patterns or rules everywhere. However, as this study points out, students have diverse views concerning their relationship to science and the natural world. Few view themselves

as part of nature or as part of science. Most do not. This study sought to uncover those world views of students that affect their views of science and the learning of biological concepts. For all of the students in this study, views of causality are embedded in supernatural and spiritual explanations. But, they also subscribe to the belief that science is fact and when presented with information that is cognitively overwhelming they cannot pass it off but will either learn it for school and never think about it again or, hold views simultaneously. Only one student of the ten interviewed seemed to be able to fully integrate science with her everyday thinking.

Examining the patterns of thinking in these elementary education majors reveals that scientific thinking is not apparent and that most students will accommodate science concepts to a point. Those concepts that fit in with what they already believe are readily accepted while others are either learned for the moment or never successfully learned at all. Understanding is not necessarily guaranteed. The extent to which students really understood the nature of science is called into question when one considers that most of these students share no interest in science and will never encounter another science class again.

Science classrooms are like alien worlds to these students and they enter them with anxiety and fear and leave with relief that it is over. What is too often left unconsidered is the motivation and interest needed and this is directly tied to what Cobern (1996) has termed items that have significant scope and force. In this case, for many students science itself does not possess enough scope and force for them to consider it seriously other than trying to pass a class. For others, there are only certain things presented in class that warrant their attention because to them they have significance. The findings of this study suggest that the model put forth by Cobern (1991) adequately describes the interplay of world views and misconceptions. There are some so called misconceptions that students will easily give up when given evidence to the contrary. However, other 'misconceptions' are embedded in the

students' world view and will either hinder understanding or understanding will occur but the student does not esteem science. Consequently, it does not become part of their cognitive framework outside of classroom assessments. And, in some cases it does not occur for assessments either.

Is it that there is an indigenous science in our society and in our students as Ogawa (1989) has suggested? Most of the students in this study view the self as separate from science and separate from nature. These students are as apt to use non-science forms of thinking and assign causality to supernatural forces. For some it is lack of prior education and for some, it is lack of interest and motivation and for others, it is that they esteem their current ways of thinking over science. "In science education, inculcation of the scientific view of man and nature and of the 'scientific' way of thinking, as if they were the only truths in the world, must result in provoking a potential antipathy against science in their minds" (Ogawa, 1986, p. 117). This may be the case in this study. Only one student, YS, seemed to both esteem and assimilate a scientific way of thinking. To address the assimilation of science thinking, theorists and researchers have recommended deploying more elaborate teaching techniques. The emotional aspect of learning science is often ignored . But, as Cobern (1996) reports "a concept or belief has force if it is central in an individual's thinking rather than marginal. A concept or belief has scope if it has relevance for the individual over a wide range of contexts" (p. 3). For science educators, there is the belief that science conceptions hold more scope and force than other ways of thinking and therefore science is seen as the most useful way of making sense of the world. This may not be the case for many of our students and simple mastery of facts may not insure understanding that finds its way in the students world view. Educators value the pursuit of scientific knowledge within a world view framework that values science while students partition or ignore concepts because it is not a goal they share with their instructors. For all but one student in this study, a world view framework embedded in science is lacking.

Some do not esteem science while others may esteem it but lack sufficient motivation to assimilate science thinking in their everyday lives.

This brings the discussion back to the question of scientific literacy. Many of these students left high school and began their post secondary educational experience without achieving what has been defined as scientific literacy. The extent to which they acquired scientific literacy by taking this class is questionable. It appears that only one of the students of the ten interviewed have what has been defined as scientific literacy. According to Cobern (1996), science education must promote science literacy by concentrating on the classroom environment. Accordingly, that classroom environment should foster critical dialogue and meaning-making with students. This environment should connect students' personal or lived view of science with the articulated world view of science itself. To do so would, according to Cobern (1996) lead to the integration of science thinking in the students everyday life. It is unclear whether or not this type of environment will drastically increase science literacy. The classroom environment of this study was modeled after these ideas. Although students enjoyed their experience it is doubtful that they have successfully integrated science thinking in their everyday thinking. The methods used and the classroom environment did stimulate interest and motivation to learn science but the extent to which those concepts were integrated into the students lived world view varied. The other salient issue that must be examined in greater detail by research is the students view of science and the relationship of science to the self and nonself. As young adults and adults most of the students in this study viewed themselves as very alienated from science and came to the class with little motivation to learn science. The separation of science and self and nature and self and the associated world views may simply be too entrenched to lead to science literacy as defined by Rutherford and Ahlgren (1990). Either we must re-think the definition of science literacy or, examine to what extent we want students to become scientifically literate. It may not be possible to achieve science literacy for all Americans. Does that mean

it is not a worthy goal. Clearly, for many of our students it is not. Perhaps for some students dis-interest in science comes first rather than science instruction leading to student dis-interest. For some students, their world view in concert with poor instruction work together to drive students from the study of science. For others, the articulated world view of science is wonderfully aligned with their own lived world view. However, science instruction should not and cannot be for future scientists only. An agreed upon notion of what is adequate for responsible citizenship is a beginning. The conversation must continue in this area. What our students and most Americans believe is essential as far a science learning is vastly different from what scientists and science educators have put forth. It may be time to invite and involve our students in the discussion. What counts as science thinking could be expanded as we discuss with ourselves and our students the nature of science, thinking, and society.

Perhaps the most important implication of the present study is the likelihood that these different world views have a profound effect on a person's student-teaching experience and teaching style that he or she ultimately develops as a professional teacher. Thus, it behooves teacher educators to be aware of these differences and their implications for making the teacher preparation experience a meaningful one for the students enrolled in their programs.

Recommendations and summary

This study is unique because students were observed over the course of a semester where the instructor/researcher was able to form closer relationships to students. Students were comfortable in the classroom and in interviews and were willing to share their thoughts, feelings, and views. The interviews were non-structured and students were able to express their thoughts and feelings at length. Other studies required students to respond to paper and pencil items or to specific pictures that were thought to elicit their views. This study

simply sought to ask students for their views and to probe for the meaning of those views. Continued research that utilizes in-depth observations and informal interviews is necessary. Students were more than willing to share their personal views because they felt comfortable.

Overall, this study compliments and extends the research by adding another diverse sample of science students to the existing study of samples. As others (Cobern, 1993, 1995; Lawrenz and Gray, 1995; Ogunniyi, 1988; Ogunniyi et. al., 1995) have found , gender, religion, and level of education does not seem to be a factor in the influence of world views and science learning. However, students do come to us with a multiplicity of views concerning relationship and classification of Self and Nonself. In particular, most students see themselves as separate from nature and as separate from science.

Alexander and Dochy ask "what would the potential impact on learning be if teachers and students within the same classroom community internalized the notions of knowing and believing differently?" (1995, p. 415). For science educators this question becomes more complex when one considers that instructors, as well as our society, view scientific knowledge as privileged. Much of what is learned in science may not run counter to students beliefs however, if science is not esteemed then what really do students come away with? This study shows the interaction of world views, beliefs, and interests in and of science. It also shows how knowledge and belief interact. What a person knows is based on what she/he believes to be true. As such, some students were able to accommodate or assimilate science concepts with what they already knew because there was a fit with what they already believed to be true. The importance of religious and other truths can not be understated. Those religious and supernatural beliefs affect one's notions of causality and they affect how one views their relationship to nature. School knowledge and specifically school science knowledge often takes a back seat to one's beliefs for the student. At the same time, individual students personal beliefs take a back seat to learning science. The resilience of students beliefs has been aptly demonstrated by this and other studies. We are

just beginning to see the role these beliefs play in the cognitive and affective milieu of our students. Continued research on this is necessary. In particular, the affective component of beliefs must be more closely examined. For these reasons, it is imperative that research center on allowing students to openly share their thoughts and views. In addition, a research agenda should include students of different ages from a wide variety of settings. Longitudinal research would also illuminate the development and change of world views over time. If world views are firmly entrenched, research in this area could examine this resilience or, show the factors that are of sufficient scope and force that change world views. There is a fair amount of similarity in the studies completed to date, however, further examination of the influence of teachers and professors world views is needed. Cobern (1996) has suggested that science education today acts as a selective device for future scientists rather than promoting science literacy for all. The implications of this study would support that. The students in this study were all non-science majors and their interest in science was already low upon entering the class. However, the effects of the classroom environment cannot be ignored. Students perceived this class as non-threatening and reported that it was, for many of them, their only positive experience with science education. Although the students reported having a positive experience it is doubtful that any of their views were changed. In particular, most have not found a way to structure science and scientific thinking into their world view. However, the structuring of the classroom itself must be examined. If students are allowed to discuss their "indigenous science" along with the science concepts being learned does this affect the cognitive restructuring and does it promote greater interest in science? Critical dialogue that includes the multiple voices of students as meaning is shared and explored could be a superior form of instruction. An ethnographic case study of a classroom that specifically elicits this would be suggested. As a preliminary study, this research suggests that involving students and engaging in more critical dialogue with students does affect student attitude. Students reported that they

enjoyed the class but, it is not clear that they developed a greater science literacy over a class that was more traditional. However, the extent to which science thinking is accommodated for in students minds can only be garnered by this type of Socratic dialogue. Students must be presented with science as attempting to make sense of the world around them just as they are. Comparing their views with science views may be helpful. Students see the utilitarian value of science but they simply do not esteem it or have interest in something they see themselves completely divorced from. Rather than presenting science as the 'only game in town', science should be presented as the currently best, but not the only, method we have for interpreting the world around us. Teaching for accommodation or concurrent acceptance of different views is tantamount for an informed citizenry to make both personal as well as political decisions. Also, it is important to foster the kind of critical reflection of ones' views as well as those of others including science itself. In short, science must be taught in the cultural context in which it operates and, it must do so while acknowledging the cultural and social views of individual students.

The emphasis on teaching styles and pedagogical practice of the current reforms in science education have only marginally addressed the problems of science education for all. The diverse views of students must be considered in an atmosphere of a classroom that legitimizes both science and other ways of thinking and knowing. As research uncovers and better understands how people view their world, we can better understand how science can become more meaningful for everyone. Or, perhaps we will realize that science may not be an essential component of everyday thinking for most of our students. This study provides further insight into the diverse world views that elementary education majors possess. Further research must address the interplay of the power of world views in science education and how those views might successfully be negotiated within a science world view.

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Table 1

Interview Questions

1. What is nature? What is the environment?
2. How do you fit in with what you think about nature? The environment?
3. What is the natural world like?
4. How do you feel about nature?
5. In nature there are plants and animals that are more important than others.
6. Human life is qualitatively different and superior to other animals.
7. Things and events in the universe and in nature occur in a consistent patterns and can be comprehended and predicted through careful and systematic study.
8. Things and events that occur in the universe and in nature are random and unpredictable.
9. All things are interrelated- everything is part of everything else.

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